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Physical activity assessment in the general population; validated self-report methods

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Abstract

Self-reported questionnaires have been commonly used to assess physical activity levels in large cohort studies. As a result, strong and convincing evidences that physical activity can protect health are widely recognized. However, validation studies using objective measures of physical activity or energy expenditure (double labelled water, accelerometers, pedometers, etc.) indicate that the accuracy and precision of survey techniques are limited. Physical activity questionnaires could fail in estimating particularly non-vigorous physical activity. They have a disproportionate focus on volitional type exercise (i.e. biking, jogging, and walking), while not capturing the activities of daily living and low to moderate intensity movements. Energy expenditure estimates from these data are not recommended. On the other hand, despite objective tools should be the measurement of choice to assess PA level, self-reported questionnaires remain valid, and have many advantages. i.e. low costs. These kind of recalls are designed and validated for different age groups and provide value and important information, mainly about physical activity pattern. Future studies will require more precision and accuracy in physical activity measurement than those provided by traditional survey methods. We can conclude that probably a mixed approach that combines both the objective and subjective techniques involving novel devices and electronic capture of physical activity questionnaires will be more effective.

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Key words: *Physical activity. Questionnaire. Objective methods. Subjective methods.*

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ESTIMACIÓN DE LA ACTIVIDAD FÍSICA EN POBLACIÓN GENERAL; CUESTIONARIOS VALIDADOS

Resumen

Los cuestionarios auto-administrados han sido comúnmente utilizados en los estudios con grandes cohortes con el fin de evaluar la actividad física de sus participantes. Como consecuencia de ello, existe una considerable cantidad de evidencias científicas sobre el efecto protector de la actividad física sobre la salud. Sin embargo, los estudios de validación que utilizan métodos objetivos para la cuantificación de la actividad física o el gasto energético (el agua doblemente marcada, los acelerómetros, los podómetros, etc.) indican que la precisión de los cuestionarios es limitada. Los cuestionarios de actividad física pueden fallar especialmente al estimar la actividad física no vigorosa, y suelen centrarse de forma desproporcionada en los tipos de ejercicios planificados (ir en bicicleta, correr, andar,…), mientras que no suelen recoger las actividades de la vida diaria y movimientos de intensidad más moderada no planificada. La estimación del gasto energético a partir de estos datos no es recomendable. Por otro lado, y a pesar de que los métodos objetivos deberían de ser la primera elección a la hora de evaluar la actividad física, los cuestionarios se mantienen como herramientas válidas y con muchas ventajas, una de ellas, el bajo coste. Este tipo de instrumentos están específicamente diseñados y validados para diferentes grupos de edad y proporcionan información valiosa e importante, sobre todo, del patrón de actividad física. Los futuros estudios requieren de más precisión a la hora de medir la actividad física respecto a la que proporcionan los cuestionarios. Podemos concluir que probablemente un método mixto que combine los métodos objetivos y subjetivos y que incluya nuevos sistemas y registros electrónicos sería lo recomendable.

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Palabras clave: *Actividad física. Cuestionarios. Métodos objetivos. Métodos subjetivos.*

Background

In order to investigate the role of physical activity (PA) in maintaining health, many large cohort studies have been performed using self-reported PA questionnaires (PAQs). These studies have provided strong and convincing evidence that PA can protect health. Knowledge has accumulated in recent decades concerning the significance of PA in relation to a number of diseases: metabolic syndrome related disorders (insulin resistance, type 2 diabetes, dyslipidemia, hypertension, obesity), heart and pulmonary diseases (chronic obstructive pulmonary disease, coronary heart disease, chronic heart failure, intermittent claudication), muscle, bone and joint diseases (osteoarthritis, rheumatoid arthritis, osteoporosis, fibromyalgia, chronic fatigue syndrome) and cancer, depression, asthma and type 1 diabetes[1]. As a result new scientific questions (dose-response relationships; health protection in different populations; effectiveness of interventions to increase PA behaviours, etc.) are currently being researched. These kind of studies require more precision and accuracy in measurement than can be provided by the traditional survey methods.

Validation studies using objective measures of PA or energy expenditure (EE) indicate that the accuracy and precision of survey techniques are limited. A recent review of PA surveys as estimates of EE concluded that none of the 23 questionnaires evaluated had both acceptable correlations and mean differences compared to the "gold standard method", the doubly labelled water (DLW) measures of EE, at the group level, as well as reasonable individual estimates of the total energy expended in PA[2]. The authors concluded that apart from reporting errors, discrepancies between PAQs and DLW estimates may be partly attributable to 1) PAQs not including key activities related to active EE; 2) PAQs and DLW ascertaining different time periods; or 3) inaccurate assignment of metabolic equivalents to self-reported activities. Besides, small sample sizes, the use of correlation coefficients, and limited information on individual validity were also problematic[2].

Intensity of activity plays an important role in the accuracy of PA recalls, with reasonable accuracy and precision for vigorous PA, but not for less intense activities[3-5]. According to Colbert and Schoeller[6] convincing evidence for the inadequacy of our current questionnaires comes from examinations of PA in the 2003–2004 and more recently, the 2005–2006 NHANES study, in which the PA of U.S. adults was measured by accelerometer[7-8]. In these studies, the proportion of adults self-reporting enough PA to meet current recommendations was 6- to 10-fold higher than when measured by accelerometer.

Moreover, one of the most important studies in this field was performed by Atienza et al.[9], in which self-reported PA was independently associated with various health biomarkers even after adjustment for accelerometer-determined PA. Despite the uniqueness of questionnaire assessment was reported in this large population study with self-reported PA, it is important to note that accelerometers had much stronger associations and also picked up more relationships (e.g., systolic blood pressure, triglycerides, glucose, etc.) than did self-report.

Limitations

Colbert et al.[10] compared various objective and self-reported methods of measuring PA and demonstrated that all three objective measures (Sensewear armband, accelerometer and pedometer) correlated better with DLW-derived PA EE and had lower error than any of the three surveys PAQs (CHAMPS, PASE and YALE). The authors concluded that our current self-report methodologies lack precision and accuracy and thus may lead to faulty conclusions and overestimated recommendations regarding the dose of PA needed to maintain health.

It is noteworthy that none of the PAQs cited were specifically designed for activity EE estimation. It is also important to comment that despite DLW is widely considered the reference method for EE measurements, it has some limitations. One basic argument is that it only measures the energy cost of PA and not the behaviour itself. Thus, DLW does not provide relevant information regarding frequency, intensity, duration, pattern, and type of activity. Some of these components may be important predictors of specific health outcomes and knowledge of these will facilitate more accurate PA recommendations[6]. DLW is also quite expensive and requires specific expertise for its use. The cost limitation, however, is mediated in many applications, because the precision allows investigators to obtain statistically significant results with a smaller sample.

Although accelerometers cannot capture all activities (water-based activity, cycling, upper-body or resistance exercise) and are limited to the assessment of current activity, in combination with a simple PA log they have great utility, particularly in intervention studies. Reduction in cost and increased awareness of their capabilities will make them more appealing in larger studies. While there are still needs for traditional survey techniques such as the assessment of historical levels of activity among adults, or the assessment of resistance exercise, swimming, biking or activities in rough terrain, the increase in accuracy and precision available with the use of PA monitors reduces the value of traditional survey methods for most studies[7,10]. Coupled with dramatic price reductions most investigations are including the use of these monitors because of their superior accuracy and precision[6].

In relation to muscle-strengthening activities assessment, and in addition to aerobic activities, general recommendations of PA (2-3 days of muscle-streng-

thening activities in youth and in adults)[11], musculoskeletal fitness is increasingly identified as related to mortality[12] and morbidities[12-13]. Assessment of resistance/muscle strengthening activities and the associated measurement issues are similar to those suggested for aerobic PA, but accelerometers, pedometers, or DLW cannot assess involvement in this specific muscle-strengthening activities.

Controversy

Despite the major efforts placed into developing reliable and valid PAQs, they remain not sufficiently accurate for the majority of the population. The error is thought to originate from a disproportionate focus on volitional type exercise (biking, jogging, and walking), while not capturing low to moderate intensity movements that accumulate a significant proportion to total activity EE[14]. The use of self-reported behaviours will remain a staple in telephone-based and large epidemiological studies (for more information see a summary of the main PAQs in table I) but improved questionnaires should be created to enhance capturing non-exercise (household chores, standing, walking for purpose) and sedentary behaviours (sitting or lying) that are uniquely associated with public health. The inclusion of such behaviours in these questionnaires will help distinguish types of activities that might have a critical role in health and potentially distinct interactions with volitional exercise. The development of such questionnaires is ongoing for these purposes [78].

Conclusion

There will always be specific situations both in research and in clinical settings that will need self-reports; however, whenever possible, objective measures should be the measurement of choice as they will provide more accuracy for the measurement of PA and also for the measure of sedentary time.

We do not currently possess or utilize the perfect PA assessment tool. The notion that objective PA tools are more valid or accurate than non-objective tools such as PA questionnaires should be considered with caution as these tools may in fact assess different aspects of PA. Hence, the use of simple, less intrusive tools like questionnaires will always be of relevance. It is a research challenge to devise "the best method" that combines both the objective and subjective techniques involving electronic gadgetry and PAQs-based registry (special consideration to the future should be given to accelerometers and GPS of smartphones monitoring daily movement patterns, including locations and times of activities).

Given the limited validity of self-reported PA and the inability of objective measurement tools to capture

Table I
Main Physical Activity Questionnaires (PAQ) found in scientific literature classified by age groups

Age group	*Acronym*	*Definition*	*Reference*
CHILDREN (<12 AÑOS) PAQ	Activitygram Assessment	Physical Activity Recall	Cooper Institute 1999 [15]
	CDPAQ	Computer Delivered Multimedia 1-Day Physical Activity Questionnaire	Ridley et al. 2001 [16]
	CLASS	Children's Leisure Activity Study Survey Questionnaire	Telford et al. 2004 [17]
	CPAR	Computerized Physical Activity Recall	McMurray et al. 1998 [18]
	FELS PAQ	Fels Physical Activity Questionnaire for Children	Treuth et al. 2005 [19]
	GAQ	Girls Health Enrichment Multisite Study Activity Questionnaire	Treuth et al. 2003 [20]
	GSQ	Godin-Sephard Physical Activity Questionnaire	Jürisson & Jürimäe 1996 [21]
	KidActive-Q	KidActive Web-based Proxy Questionnaire	Bonn et al. 2012 [22]
	MARCA	The Multimedia Activity Recall for Children and Adolescents	Ridley et al. 2006 [23]
	MRPARQ	Many Rivers Physical Activity Recall Questionnaire	Gwynn et al. 2010 [24]
	OPAQ	Oxford Physical Activity Questionnaire	Lubans et al. 2008 [25]

Table I *(cont.)*
Main Physical Activity Questionnaires (PAQ) found in scientific literature classified by age groups

Age group	*Acronym*	*Definition*	*Reference*
	PAQ-C	Physical Activity Questionnaire for Older Children	Crocker et al. 1997 [26]
	PAQ-S	Physical Activity Questionnaire for Schoolchildren	Manios et al. 2013 [27]
		Parental Report Outdoors Questionnaire	Burdette et al. 2004 [28]
	Pre-PAQ	Pre-school-age Children's Physical Activity Questionnaire	Dwyer et al. 2011 [29]
	SAPAC	Self-Administered Physical Activity Checklist	Sallis et al. 1996 [30]
	SHAPES PAQ	School Health Action, Planning Evaluation System Physical Activity Questionnaire	Wong et al. 2006 [31]
	Y-PASS Questionnaire	Youth Physical Activity Survey for Specific Settings	Stanley et al. 2014 [32]
ADOLESCENT (12-16 years) PAQ	LTEQ	Leisure Time Exercise Questionnaire	McCormack & Giles-Corti 2002 [33]
	PTLAQ	Past Year Leisure Time Activity Questionnaire	McCormack & Giles-Corti 2002 [33]
	PDPAR	Previous Day Physical Activity Recall	McCormack & Giles-Corti 2002 [33]
	APARQ	Adolescent Physical Activity Recall Questionnaire	McCormack & Giles-Corti 2002 [33]
	MACQ	Modifiable Physical Activity Questionnaire for Adolescents	McCormack & Giles-Corti 2002 [33]
	YRBS	Youth Risk Behaviour Survey	Troped et al. 2007 [34]
	SAPAC	Self-Administratered Physical Activity Checklist	Ekelund et al. 2006 [35]
	WAC	Weekly Activity Checklist (modified)	Mota et al. 2002 [36]
	IPAQ-A	International Physical Activity Questionnaire for Adolescents	Hagströmer et al. 2008 [37]
	BAD	Bouchard Activity Diary	Martinez-Gómez et al. 2010 [38]
	PAQ-A	Physical Activity Questionnaire for Adolescents	Kowalski et al. 1997 [39]
	HBSC	Health Behaviour in School Children Questionnaire	Rangul et al. 2008 [40]
ADULTS (16-65 years) PAQ	CBPAQ	Cognitive Behavioral Physical Activity Questionnaire	Schembre et al. 2014 [41]
	PPAQ	Paffenbarger Physical Activity Questionnaire Among Healthy Adults	Simpson 2011 [42]
	MLTAQ	Minnesota Leisure Time Physical Activity Questionnaire	Elosua R et al. 1994 for Spanish men [43] Elosua R et al. 2000 for Spanish women [44]
	IPAQ	International Physical Activity Questionnaire	Dweyer et al. 2011 [29]
	IPAQ-L	International Physical Activity Questionnaire-Long Version	Hagströmer et al. 2006 [45]
	1WPAR	One-Week Physical Activity Recall	Timperio et al. 2003 [46]
	7DPAR	7-Day Physical Activity Recall	Conway et al. 2002 [47]
	7-DR	7-Day Recall	Bonnefoy et al. 2001 [48]

Table I ***(cont.)***
Main Physical Activity Questionnaires (PAQ) found in scientific literature classified by age groups

Age group	*Acronym*	*Definition*	*Reference*
	AAFQ	Arizona Activity Frequency Questionnaire	Staten et al. 2001 [49]
	AAS	Active Australian Survey	Brown et al. 2008 [50]
	AWAS	Australian Women's Activity Survey	Fjeldsoe et al. 2009 [51]
	BAD	Bouchard Activity Diary	Martinez-Gomez et al. 2010 [38]
	BAQ	Bouchard Activity Questionnaire	Philippaerts et al. 1999 [52]
	BAQ- mod	Baecke Activity Questionnaire Modified Version	Bonnefoy et al. 2001 [48]
	CAPS-4WR	Cross-cultural Activity Participation Study-4 Weeks Activity Recall	Mahabir et al. 2006 [53]
	CAPS-TWR	Cross-cultural Activity Participation Study - Typical Week Activity Recall	Mahabir et al. 2006 [53]
	FCPQ	Five City Project Questionnaire	Mahabir et al. 2006 [53]
	FPACQ	Flesmish Physical Activity Computerized Questionnaire	Matton et al. 2007 [54]
	GPAQ	Global Physical Activity Questionnaire	Bull et al. 2009 [55]
	HEPA99	Swiss Health Enhancing Physical Activity Survey 1999	Mader et al. 2006 [56]
	HUNT2	Nord-Trondelag Health Study Questionnaire-Version 1	Kurtze et al. 2007 [57]
	KPAS	Kaiser Physical Activity Survey	Ainsworth et al. 2000 [58]
	KPAS-mod	Kaiser Physical Activity Survey- Modified Version	Smichtd et al. 2006 [59]
	MLTPAQ	Minnesota Leisure Time Physical Activity Questionnaire	Slinde et al. 2003 [60]
	NHS-PAQ	Nurses' Health Study II- Physical Activity Questionnaire	Pettee-Gabriel et al. 2009 [61]
	OIMQ	Office in Motion Questionnaire	Mader et al. 2006 [56]
		Occupational Physcial Activity Questionnaire	Reis et al. 2005 [62]
	PAAT	Physical Activity Assessment Total	Meriwether et al. 2006 [63]
	PMMAQ	Past Month – Modifiable Activity Questionnaire	Pettee-Gabriel et al. 2009 [61]
	PWMAQ	Past Week Modifiable Activity Questionnaire	Pettee-Gabriel et al. 2009 [61]
	PYTPAQ	Past-year Total Physical Activity Questionnaire	Friedenreich et al. 2006 [64]
	RPAQ	Recent Physical Activity Questionnaire	Besson et al. 2010 [65]
	S7DR	Stanford 7 - Day Recall	Richardson et al. 2001 [66]
		Scottish Physical Activity Questionnaire	Lowther et al. 1999 [67]
	SAPAC-modified	Self-Administered Physical Activitiy Checklist	Affuso et al. 2011 [68]
	OSPAQ	Occupational Sitting and PAQ	Chau et al. 2012 [69]
	MOSPA-Q	MONICA Optional Study on Physical Activity Questionnaire	Roeykens et al. 1998 [70]

Table I (cont.)
Main Physical Activity Questionnaires (PAQ) found in scientific literature classified by age groups

Age group	*Acronym*	*Definition*	*Reference*
ELDERLY (>65 years) PAQ	CHAMPS	Community Healthy Activities Model Program for Seniors	Harada et al. 2001 [71]
	CHAMPS-MMSCV	Healthy Activities Model Program for Seniors - Modified Mailed Self-Complete Version	Giles & Marshall 2009 [72]
	DQ-mod	Dallosso Questionnaire-Modified Version	Bonnefoy et al. 2001 [48]
	IPAQ-E	International Physical Activity Questionnaire Short Version Modified for Elderly	Hurtig-Wennlöf et al. 2010 [73]
	PAQ-EJ	Physical Activity Questionnaire for Elderly Japanese	Yasunaga et al. 2007 [74]
	PASE	Physical Activity Scale for the Elderly	Washburn et al. 1993 [75]
	QPASE	Questionnaire d'Activitév Physique Saint-Etienne	Bonnefoy et al. 2001 [48]
	VAPAQ	Veterans Physical Activity Questionnaire	Betz et al. 2014 [76]
	YPAS	Yale Physical Activity Survey	Dipietro et al. 1993 [77]

all types of PA, a hybrid approach may be optimal for future PA assessments. Indeed, continuous advancements in the technology of objective PA assessment tools combined with online self-reported PA data collection are likely to lead the way in the following years towards a modernized and, potentially, more accurate and comprehensive estimation of PA with the inclusion of objective monitoring in very large observational studies.

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